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Original Research Article

Ocular Manifestations in Eye Injuries Following Road Traffic Accidents in Patients Attending a Tertiary Eye Care Centre in South Kerala

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Abstract:

Background: Road traffic accidents cause avoidable ocular morbidity, especially among young road users and two-wheeler riders. Local data help clinicians identify high-risk injury patterns and guide prevention.

Methods: This descriptive study included 545 patients with ocular trauma after road traffic accidents who attended Regional Institute of Ophthalmology, Thiruvananthapuram, during 1 year after ethics committee clearance. Patients presenting within 3 days of injury were included. Demographic profile, injury circumstances, protective wear, alcohol use, presenting visual acuity, anatomical findings and BETT classification were recorded. Data were analysed with proportions, chi-square and ordinal logistic regression.

Results: Mean age was 33.74 ± 12.02 years. Males formed 69.7% of the cohort. The 21-30 year group was largest, 38.7%. Two-wheeler crashes accounted for 72.5%. Night-time injuries formed 59.6%. Protective wear was absent in 70.1%, and alcohol use was recorded in 28.1%. Normal or mild visual impairment was seen in 75.0%, while 25.0% had moderate-or-worse visual impairment. Lid injury was the commonest manifestation, 57.1%, followed by conjunctival injury, 40.9%, and corneal injury, 27.9%. Closed globe injury was recorded in 34.9%, open globe injury in 9.9%, traumatic optic neuropathy in 5.0%, and orbital fracture in 14.5%. Increasing age, male sex and two-wheeler involvement independently predicted greater visual impairment. Protective wear reduced the severity.

Conclusion: Road traffic accident-related ocular trauma in this South Kerala cohort mainly affected young male two-wheeler users. Lack of protective wear, severe globe injury, posterior segment injury and traumatic optic neuropathy marked higher visual risk.

Keywords: Road Traffic Accidents, Ocular Trauma, Visual Impairment, Protective Wear.

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Introduction

Road traffic injury is a major public health problem. The World Health Organization reports 1.19 million deaths each year from road traffic crashes.[1] Road traffic injuries also lead death among children and young adults aged 5-29 years.[1] Low- and middle-income countries carry 92% of road deaths, although they hold around 60% of the world vehicle fleet.[1] Vulnerable road users, including motorcyclists, cyclists and pedestrians, account for more than half of road deaths.[1] Eye injury adds a specific burden to this wider trauma problem because even unilateral visual loss affects work, mobility and quality of life.[2]

Ocular trauma has a distinct epidemiology. Négrel and Thylefors described the global impact of eye injuries and framed ocular trauma as a cause of unilateral blindness and preventable disability.[2] Standard classification also matters. The Birmingham Eye Trauma Terminology system created a common language for mechanical eye injury.[3] The Ocular Trauma Score helped clinicians describe prognosis with greater consistency [4]. Indian studies show repeated patterns of young male predominance after road traffic ocular trauma. [5,6] Two-wheeler exposure appears often in Indian series and in recent two-wheeler-focused work. [7,8] Alcohol exposure and absent safety measures also recur in hospital-based reports. [5,9]

South Kerala has dense traffic, high two-wheeler use and large referral flows to tertiary eye care. Bokhari and Rani Sujatha reported soft tissue injuries as the commonest ocular manifestation in road traffic accidents.[5] Shetgar et al reported closed globe injuries as a frequent pattern in a hospital-based case series.[6] Krishna reported eyelid involvement and subconjunctival haemorrhage as common findings in a regional eye hospital cohort.[7] Ramani et al focused on two-wheeler-associated ocular injuries and the role of helmets.[8] Local data focused on eye injuries following road traffic accidents remain limited. This study analysed ocular manifestations, visual severity and associated factors among patients presenting to a tertiary eye care centre in South Kerala.

The clinical value of such data lies in early triage. Many road traffic accident patients first present to casualty, orthopaedics, emergency medicine or maxillofacial services. Eye symptoms might receive less attention when head injury, fracture or soft tissue bleeding dominates the first assessment. A structured description of common ocular findings helps non-ophthalmic teams decide when to seek urgent eye review. A local risk profile also helps public health teams link ocular trauma prevention with helmet use, seatbelt use, alcohol control and safer two-wheeler travel. [1,8-10]

Aims & Objectives

Aim: To study ocular manifestations among patients presenting with eye injuries after road traffic accidents at a tertiary eye care centre in South Kerala.

Objectives

Primary Objective: To describe ocular manifestations in patients presenting with eye injuries after road traffic accidents.

Secondary Objective: To identify factors associated with the severity of eye injury, using presenting visual acuity as the main severity marker.

Material & Methods

Study Design: This is a hospital based descriptive study conducted in a tertiary eye care centre in South Kerala from May 2024-June 2024 on 545 patients presenting to the outpatient department or casualty with ocular trauma after a road traffic accident. Following approval and clearance from institution ethics committee participants were enrolled in the study after obtaining informed written consent. The study used a structured clinical proforma and master chart for patients presenting with ocular trauma after road traffic accidents.

Patients with visual loss before the injury, previous head or ocular trauma, or ongoing treatment for vision-threatening ocular disease were excluded.

Sample Size: The sample size was 545. The calculation used an expected orbital fracture proportion of 15.07% from previous research (study by Rani Suajatha et al) 95% confidence level and 20% relative precision.

Sampling size and selection –

$$\text{Sample size}(n)=\frac{(z_{1-\alpha/2})^{2*}(p)(q)}{(d)^2}$$

n = Desired sample size

$Z1-\alpha/2$ = Critical value and a standard value for the corresponding level of confidence. (At 95% CI or 5% level of significance (type-I error) it is **1.96**)

P = Expected prevalence or based on previous research

q = 1-p

d = Margin of error or precision

Assuming that orbital fractures of (15.07%) among RTA victims*, the study would require a sample size of 545.

Sample size estimated with 20% precision relative to the expected proportion (i.e. 0.2 × 15.07 = 3.01%).

Study Procedure: Demographic details and injury details were recorded. These includes age, sex, residence, mode of injury, affected eye, agent causing injury, time of injury, protective wear and alcohol use. Protective wear included spectacles, helmet or seatbelt.

Each patient underwent ocular examination. Presenting visual acuity was recorded. Slit lamp examination, posterior segment evaluation and relevant imaging were performed according to clinical need. Injuries were classified by anatomical site. Mechanical globe injuries were classified using BETT categories. Management was recorded as medical or surgical.

Presenting visual acuity was used as the functional severity marker because it is available at first contact and influences urgency of referral, counselling and treatment. Anatomical classification separated lid, conjunctival, corneal, anterior chamber, lens, posterior segment, traumatic optic neuropathy and orbital fracture findings. This approach allowed both descriptive reporting and analysis of clinical factors linked with reduced vision.

Statistical Analysis: Data were analysed with SPSS version 26. Continuous variables were summarised using mean, standard deviation, median and interquartile range. Categorical variables were summarised as frequency and percentage.

Presenting visual acuity was grouped as normal or mild visual impairment, moderate visual impairment, and severe visual impairment or blindness. For bivariate analysis, visual acuity was dichotomised as normal/mild versus moderate-or-worse visual impairment. Chi-square test assessed associations between risk factors and moderate-or-worse visual impairment. A p value below 0.05 was considered statistically significant.

Ordinal logistic regression assessed independent predictors of presenting visual acuity severity. The model included age, sex, residence, night-time injury, protective wear, alcohol use and two-wheeler involvement. Four records with missing time or alcohol entries were excluded from adjusted analysis.

Results

The study included 545 patients. The mean age was 33.74 ± 12.02 years, with a median age of 32 years and interquartile range of 26-40 years. Age ranged from 8 to 78 years. The largest age group was 21-30 years, 38.7%. Males formed 69.7% of the cohort. Urban residence was recorded in 78.7%.

Table 1: Sociodemographic distribution of study participants (n=545)

Variable	n or value	%
Age, mean ± SD (years)	33.74 ± 12.02	
Age, median (IQR) years	32 (26-40)	
Age range (years)	8-78	
≤20 years	43	7.9
21-30 years	211	38.7
31-40 years	158	29.0
41-50 years	83	15.2
51-60 years	29	5.3
>60 years	21	3.9
Male	380	69.7
Female	165	30.3
Urban	429	78.7
Rural	116	21.3

Two-wheeler accidents were the commonest mode of injury, 72.5%. The right eye was affected in 56.5% and the left eye in 43.3%. Night-time injuries formed 59.6%. No protective wear was recorded in 70.1%. Alcohol use was present in 28.1%.

Table 2: Distribution of injury-related characteristics

Variable	Category	n	%
Mode of injury	Pedestrian	58	10.6
	Two-wheeler	395	72.5
	Three-wheeler	47	8.6
	Four-wheeler	25	4.6
	Others	20	3.7
Affected eye	Right eye	308	56.5
	Left eye	236	43.3
	Not recorded	1	0.2
Time of injury	Day	217	39.8
	Night	325	59.6
	Not recorded	3	0.6
Protective wear	No protective wear	382	70.1
	Spectacles	42	7.7
	Helmet	107	19.6
	Seatbelt	14	2.6
Alcohol use	Yes	153	28.1
	No	391	71.7
	Not recorded	1	0.2

At presentation, 55.2% had visual acuity between 6/6 and 6/12. Moderate-or-worse visual impairment was present in 25.0%. Total blindness with no perception of light was recorded in 0.6%. This means three out of four patients reached care with normal or mild visual impairment, but a substantial subgroup already had vision-threatening injury at first assessment. Lid injury was the most frequent manifestation, 57.1%, followed by conjunctival injury, 40.9%, and corneal injury, 27.9%. Orbital fracture was present in 14.5%, and traumatic optic neuropathy in 5.0%.

Table 3: Presenting visual acuity and grouped severity

Visual Acuity Category	n	%
6/6-6/12, normal or mild	301	55.2
6/12-6/18, mild	108	19.8
6/18-6/60, moderate	53	9.7
6/60-3/60, severe	17	3.1
<3/60-1/60, profound blindness	28	5.1
1/60-perception of light, near total blindness	35	6.4
No perception of light, total blindness	3	0.6
Grouped severity: normal/mild	409	75.0
Grouped severity: moderate	53	9.7
Grouped severity: severe/blindness	83	15.2

Table 4: Ocular manifestations by anatomical site

Site	Finding	n	%
Lid	No lid injury	234	42.9
	Ecchymosis	225	41.3
	Other lid injury	13	2.4
	Lid laceration	56	10.3
	Canalicular injury	13	2.4
	Other or multiple lid injury	4	0.7
Conjunctiva	No conjunctival injury	322	59.1
	Subconjunctival haemorrhage	157	28.8
	Conjunctival tear	66	12.1
Cornea	No corneal injury	393	72.1
	Abrasion or epithelial defect	63	11.6
	Self-sealed wound	39	7.2
	Full-thickness wound	50	9.2
Posterior segment	No posterior segment injury	480	88.1
	Vitreous haemorrhage	21	3.9
	Other retinal injury	2	0.4
	Retinal whitening	26	4.8
	Retinal detachment	2	0.4
	Intraocular foreign body	10	1.8
	Choroidal rupture	4	0.7
Traumatic optic neuropathy	Present	27	5.0
Orbital fracture	Present	79	14.5

BETT classification showed closed globe injury in 34.9% and open globe injury in 9.9%. Medical or conservative management was recorded in 76.7%, while surgical management was recorded in 22.9%.

Table 5: BETT classification and management

Variable	Category	n	%
BETT group	No mechanical globe injury by BETT	301	55.2
	Closed globe injury, total	190	34.9
	Open globe injury, total	54	9.9
BETT detailed class	Closed globe injury, unspecified	3	0.6
	Contusion	135	24.8
	Lamellar laceration	52	9.5
	Rupture	24	4.4
	Penetrating wound	27	5.0
	Intraocular foreign body	3	0.6
Management	Medical or conservative	418	76.7
	Surgical	125	22.9
	Not recorded	2	0.4

Bivariate analysis showed significant associations between moderate-or-worse visual impairment and age group, sex, mode of injury, absence of protective wear, alcohol use, corneal injury, posterior segment injury, traumatic optic neuropathy, BETT group and management. Residence and orbital fracture were not significant in this analysis. The most pronounced clinical gradients were seen with traumatic optic neuropathy, posterior segment injury and open globe injury. These findings identified a small but high-risk subgroup needing rapid specialist care.

Table 6: Factors associated with moderate-or-worse presenting visual acuity

Variable	Category	Moderate-or-worse VA / total	%	p value
Age group	≤20 years	3/43	7.0	<0.001
	21-30 years	44/211	20.9	
	31-40 years	40/158	25.3	
	41-50 years	38/83	45.8	
	51-60 years	4/29	13.8	
	>60 years	7/21	33.3	
Sex	Male	107/380	28.2	0.012
	Female	29/165	17.6	
Mode of injury	Pedestrian	11/58	19.0	0.001
	Two-wheeler	110/395	27.8	
	Three-wheeler	4/47	8.5	
	Four-wheeler	2/25	8.0	
	Others	9/20	45.0	
Protective wear	No	122/382	31.9	<0.001
	Yes	14/163	8.6	
Alcohol use	Yes	57/153	37.3	<0.001
	No	79/391	20.2	
Corneal injury	Absent	65/393	16.5	<0.001
	Present	71/152	46.7	
Posterior segment injury	Absent	86/480	17.9	<0.001
	Present	50/65	76.9	
Traumatic optic neuropathy	Absent	109/518	21.0	<0.001
	Present	27/27	100.0	
BETT group	No mechanical globe injury by BETT	4/301	1.3	<0.001
	Closed globe injury	80/190	42.1	
	Open globe injury	52/54	96.3	

Ordinal logistic regression included 541 patients. Increasing age, male sex and two-wheeler involvement independently predicted greater visual acuity severity. Protective wear had a protective association. Residence, night-time injury and alcohol use were not independently significant after adjustment.

Table 7: Ordinal logistic regression for presenting visual acuity severity

Variable	Adjusted odds ratio	95% CI	p value
Age, per 10 years	1.58	1.32-1.90	<0.001
Male sex	1.93	1.13-3.31	0.016
Rural residence	1.01	0.61-1.66	0.977
Night-time injury	0.78	0.49-1.26	0.313
Protective wear used	0.17	0.09-0.31	<0.001
Alcohol use	1.36	0.83-2.23	0.218
Two-wheeler involvement	2.88	1.62-5.11	<0.001

Discussion

This study shows a clear road traffic trauma pattern in South Kerala. Young adults formed the largest group, and males outnumbered females by more than two to one. WHO data show road traffic mortality concentrates in young age groups and males.[1] The mean age of 33.74 years in this study is close to the 32-year mean reported by Bokhari and Rani Sujatha in their road traffic accident series.[5] Shetgar et al and Krishna also reported high involvement of young adults in Indian hospital cohorts.[6,7] Nalukenge et al found male sex independently associated with ocular injury among road traffic accident patients in Uganda.[9]

Two-wheeler accidents dominated this cohort. They accounted for 72.5% of injuries. This finding has direct preventive value. WHO identifies motorcyclists as vulnerable road users.[1] Bokhari and Rani Sujatha reported young male vulnerability in road traffic accident-related ocular manifestations.[5] Krishna reported two-wheeler commuting as an important exposure in a regional eye hospital cohort.[7] Ramani et al focused specifically on two-wheeler-associated ocular injuries and helmet protection.[8] The current data support focused helmet enforcement, rider education and pillion protection in South Kerala.

Protective wear showed a strong relationship with severity. No protective wear was recorded in 70.1% of patients. Moderate-or-worse visual impairment occurred in 31.9% of those without protective wear and 8.6% of those with protective wear. WHO reports large reductions in death and brain injury with correct helmet use.[1] Ramani et al examined helmet protection in two-wheeler-associated ocular trauma.[8] Nalukenge et al found ocular injuries were more common among road users who did not use safety measures.[9] Helmets and seatbelts are not eye-specific devices, yet they reduce impact energy and facial contact with road, glass and vehicle surfaces.

Alcohol use was present in 28.1%. In bivariate analysis, alcohol use associated with moderate-or-worse visual impairment. In adjusted analysis, alcohol did not retain independent significance. This pattern suggests alcohol marks a high-risk crash context, but some of its effect overlaps with age, sex, time of injury, two-wheeler use or absence of protective wear. WHO lists drink-driving as a major road safety risk.[1] Bokhari and Rani Sujatha also highlighted alcohol exposure among road traffic accident patients with ocular injuries.[5] Nalukenge et al analysed alcohol and other behavioural factors in adult road traffic accident patients.[9] The present result supports combined action on alcohol, helmet use and rider behaviour.

Lid, conjunctival and corneal injuries formed the leading anatomical manifestations. Lid injury occurred in 57.1%, conjunctival injury in 40.9% and corneal injury in 27.9%. Bokhari and Rani Sujatha reported soft tissue injuries as the commonest manifestations.[5] Shetgar et al described closed globe injuries and ocular surface findings in their hospital series.[6] Krishna reported eyelid involvement and subconjunctival haemorrhage as common findings.[7] Brody et al also reported eyelid involvement, subconjunctival haemorrhage and corneal injury among motor vehicle accident-related ocular injuries.[10] The high frequency of external and anterior segment findings supports routine ocular screening in facial trauma.

The severity profile deserves attention. One in four patients had moderate-or-worse visual impairment at presentation. Open globe injury occurred in 9.9%, and traumatic optic neuropathy occurred in 5.0%. Posterior segment injury and traumatic optic neuropathy had the strongest clinical association with poor presenting visual acuity. BETT helps separate closed globe and open globe injury in a standard way.[3] The Ocular Trauma Score literature supports initial visual acuity and injury features as key prognostic information.[4] Brody et al reported long-term functional issues after motor vehicle accident-related ocular injuries.[10]

Closed globe injury was more common than open globe injury. Shetgar et al reported a similar predominance of closed globe injury.[6] Krishna also described closed globe injury as a common pattern after road traffic accidents.[7] Ramani et al studied two-wheeler-associated ocular injuries, where helmet protection remains central to prevention.[8] Yet open globe injury carries high visual risk despite lower frequency. The distinction supports use of BETT at the first point of ophthalmic assessment.[3] Adding presenting visual acuity severity strengthens triage because visual acuity captures functional loss at the time of arrival.[4]

This study has strengths. The sample size was large for a single-centre ocular trauma study. The proforma captured demographic, behavioural, anatomical and management variables. The analysis moved beyond description by testing factors linked to presenting visual acuity severity and by using ordinal logistic regression. The results give direct local prevention targets: two-wheeler users, non-use of protective wear, and early recognition of posterior segment or optic nerve injury.

The study also has limitations. It was hospital based, so the results describe patients reaching a tertiary eye care centre and do not estimate community incidence. Follow-up visual outcome was not included in the supplied dataset, so the analysis focuses on presenting visual acuity. Some variables had small numbers in severe categories. Time from injury to presentation and exact helmet quality or seatbelt use were not analysed in depth. Future studies should include follow-up visual acuity, helmet type, visor use, crash speed, imaging details and treatment timing.

The findings support a simple clinical and public health response. First, record visual acuity in every road traffic accident patient with facial or ocular trauma. Second, screen for posterior segment injury and traumatic optic neuropathy when visual acuity is reduced. Third, classify mechanical eye injuries using BETT.[3] Fourth, strengthen two-wheeler helmet use, including full-face protection and pillion use. [1,8] Fifth, integrate eye injury prevention into road safety education, enforcement and emergency care pathways. [1,9]

For emergency services, the main practical point is consistency. Visual acuity should be treated like a vital sign in facial trauma. A torch examination alone misses functional severity. A patient with periocular swelling, subconjunctival haemorrhage or lid injury still needs visual acuity recording, pupil assessment and anterior segment review. Reduced vision, hyphaema, full-thickness corneal wound, abnormal pupil, suspected open globe, posterior segment symptoms or optic nerve signs should trigger urgent ophthalmology referral. This pathway reduces missed severe injury and improves documentation for treatment decisions.

For prevention teams, the main message is targeted. A broad road safety message reaches many people but often fails to change the highest-risk behaviour. The present cohort points to two-wheeler riders, young adult males, night travel, alcohol exposure and absent protective wear. Helmet campaigns should include eye protection and visor use. Pillion riders should be included. Police, transport departments, schools, colleges and workplaces should deliver the same message: protect the head and eyes on every ride, including short local travel. Eye hospitals should share local injury data with road safety authorities so enforcement and education reflect regional patterns.

The results also support a data-driven casualty checklist. A short road traffic ocular trauma checklist should record mode of travel, helmet or seatbelt use, alcohol exposure, time of crash, visual acuity in both eyes, pupil findings, anterior segment findings, posterior segment status when visible, suspected optic nerve injury and BETT class. Such a checklist improves handover from casualty to ophthalmology. It also creates audit data for prevention. In this study, four fields had missing entries, which shows the value of standardised documentation at first contact.

A final implication relates to counselling. Patients with lid injury or subconjunctival haemorrhage often perceive the injury as minor when vision appears preserved. Clinicians should explain warning symptoms, including worsening vision, pain, floaters, flashes, diplopia, increasing redness and inability to open the eye. Patients with open globe injury, posterior segment injury or traumatic optic neuropathy need urgent counselling about prognosis and follow-up. This approach links acute care with prevention of delayed complications.

The study also gives a baseline for service planning. Surgical care was required in nearly one quarter of patients. Eye casualty staffing, theatre access, imaging links and trauma referral pathways should reflect this workload. A tertiary eye centre receiving road traffic injury referrals needs capacity for both common minor injuries and less frequent vision-threatening injuries.

Conclusion

Road traffic accident-related ocular trauma in this South Kerala tertiary eye care cohort mainly affected young male two-wheeler users. Most patients had normal or mild presenting visual acuity, but one in four had moderate-or-worse visual impairment.

Lid, conjunctival and corneal injuries were the commonest manifestations. Open globe injury, posterior segment injury and traumatic optic neuropathy marked the highest visual risk. Increasing age, male sex and two-wheeler involvement independently predicted greater visual severity, while protective wear reduced severity.

These findings support stronger helmet and seatbelt use, early visual acuity recording, structured ocular examination, BETT-based classification and rapid referral for vision-threatening injury.

Declarations

Ethics Approval: The study was conducted after approval from the Research Committee and Institutional Human Ethics Committee

Informed Consent: Written informed consent was obtained from all study participants before enrolment.

Conflict of Interest: The authors declare no conflict of interest.

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Author Contributions: All authors contributed to study conception, data collection, data analysis, manuscript preparation and final approval of the manuscript.

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